High End Computing Revitalization Task Force Update

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Director

National Coordination Office for

Information Technology Research and Development

CASC Members Meeting

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HECRTF – OMB Guidance in FY04 Budget

OMB Analytical Perspectives, Budget of the United States Government, FY2004, Page 177: "… Due to its impact on a wide range of federal agency missions ranging from national security and defense to basic science, high end computing—or **supercomputing** —capability is becoming **increasingly critical**. Through the course of 2003, agencies involved in developing or using high end computing will be engaged in planning activities to guide future investments in this area, coordinated through the NSTC. The activities will include the development of an **interagency R&D roadmap for high-end computing core technologies**, a **federal high-end computing capacity and accessibility improvement plan**, and a discussion of issues (along with recommendations where applicable) relating to federal **procurement** of high-end computing systems. The knowledge gained from this process will be used to guide future investments in this area. Research and software to support high end computing will provide a foundation for future federal R&D by improving the effectiveness of core technologies on which next-generation high-end computing systems will rely."

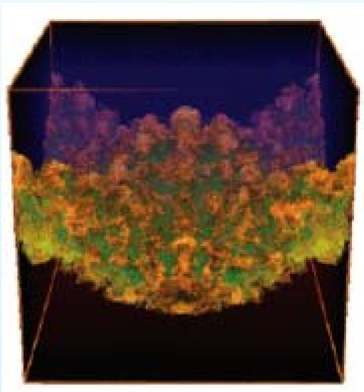
Purpose of High-End Computing Revitalization Task Force (HECRTF)

- **Inter-agency planning activity**
  - Develop 5-year plans/roadmaps to improve how the federal government develops, purchases, and provisions high-end computing (HEC)
  - Participants include DoD (DARPA, DoD HPC Modernization Program, NSA, Missile Defense Agency), DOE(NNSA, Science), EPA, NASA, NIH, NSF, NIST, NOAA, OMB, OSTP (approx. 60 people)
  - Focus on advancing Agency/end-user needs in HEC
- **Established by the Office of Science and Technology Policy, under the auspices of the National Science and Technology Council.**

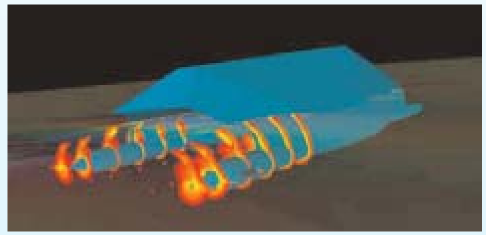
HECRTF Charge

- Handout
- http://www.itrd.gov/hecrtf/public_hecrtf_charge.pdf

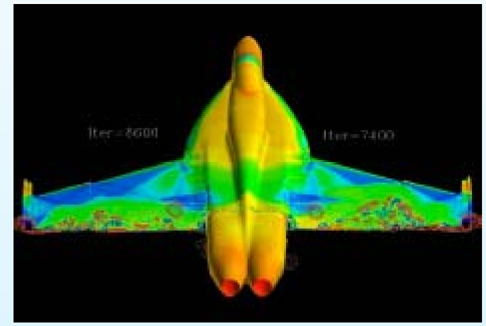
Applications of High-End Computing:
Big Problems with Big Impacts



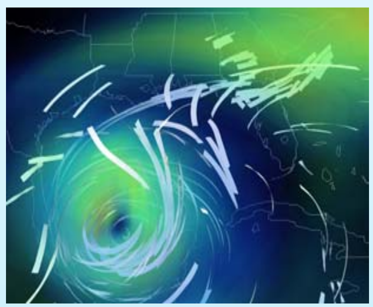
Nuclear Stockpile Stewardship



Ship Design

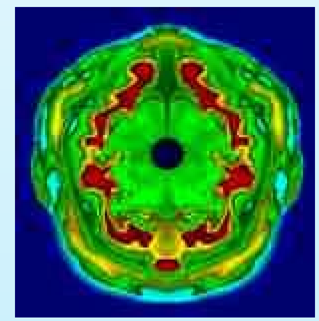


Aeronautics

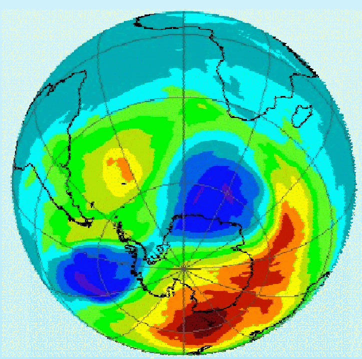


Weather Prediction

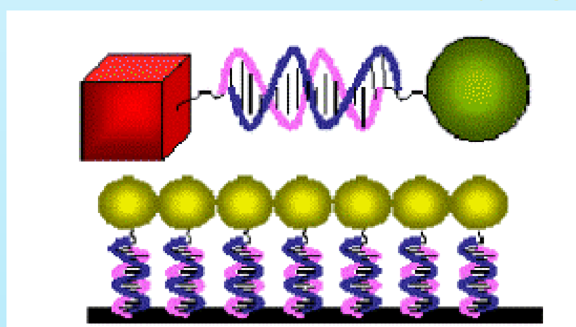
Cryptography



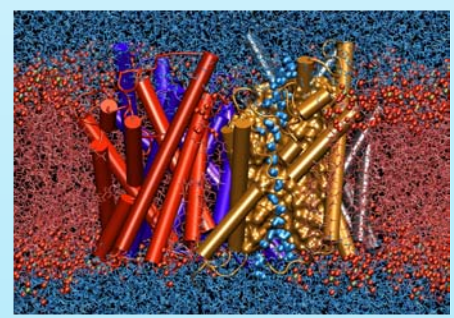
Astrophysical Simulation



Climate Modeling



Nano-Science



Biology

Opportunities for Advancing Science Will Continue in Existing and New Areas

Application	Science Accomplishment	Required Capability Multiple	Benefit to Nation
Signals Intelligence	Model, simulate, and exploit foreign codes, ciphers and complex communications systems.	**1000**	Supports U.S. policy makers, military commands and combat forces with information critical to national security, force protection and combat operations.
Directed Energy	To advance the directed energy systems design process out of the scientific research realm into the engineering design realm	**1000**	Ability to efficiently design next generation directed energy offensive and defensive weapon systems. Change the design process from years to days.
Signals Image Processing & Automatic Target Recognition	To replace electromagnetic scattering field tests of actual targets with numerical simulations of virtual targets	**1000**	Creates the ability to design more stealthy aircraft, ships, and ground systems and creates the ability to rapidly model new targets enabling more rapid adaptation of fielded weapon systems' ability to target new enemy weapon systems.
Integrate Modeling and Test of Weapon Systems	To model complex system interaction in real time with precision	**1000**	Creates the ability to replace many expensive, dangerous and time consuming ground tests with virtual tests resulting in lower test costs and more rapid development of weapon systems.
Climate Science	Resolve additional physical processes such as ocean eddies, land use patterns, and clouds in climate and weather prediction models.	**1000**	Provide U.S. policymakers with leading-edge scientific data to support policy decisions. Improve climate and weather prediction skill at timescales from minutes to decades.
Weather and Short-term Climate Prediction	Enable dynamical prediction of frequency and intensity of occurrence of hurricanes/typhoons and severe winter storms 90 days in advance.	**1000**	Provides critical support to deployed naval, air and land forces in local, regional and global combat environments. Lives saved and economic losses avoided due to better severe weather prediction.
Solid Earth Science	Dynamic earthquake forecasting with 5 year lead time.	**100**	Provide prioritized retrofit strategies. Reduced loss of life and property. Damage mitigation.
Space Science	Realistically simulate explosive events on the sun, the propagation of the energy and particles released in the event through the interplanetary medium, and their coupling to Earth's magnetosphere, ionosphere, and thermosphere.	**1000**	Provide decision makers (both civilian and military) with status and accurate predictions of space weather events on time scales of hours to days.
Subsurface Contamination Science	Simulate the fate and transport of radionuclides and organic contaminants in the subsurface.	**1000**	Predict contaminant movement in soils and ground water and provide a basis for developing innovative technologies to remediate contaminated soils and ground water.

National Security

Environment

Opportunities for Advancing Science Will Continue in Existing and New Areas

Application	Science Accomplishment	Required Capability Multiple	Benefit to Nation
Magnetic Fusion Energy	Optimize balance between self-heating of plasma and heat leakage c aused by electromagnetic turbulence.	**100**	Underpins U.S. decisions about future international fusion collaborations. Integrated simulations of burning plasma crucial for quantifying prospects for commercial fusion.
Combustion Science	Understand interaction s between combustion and turbulent fluctuations in burning fluid.	**100**	Understand detonation dynamics (for example, engine knock) in combustion systems. Solve the "soot" problem in diesel engines.
Astrophysics	Realistically simulate the explosion of a supernova for the first time.	**1000**	Measure size and age of Universe and rate of expansion of Universe. Gain insight into inertial fusion processes.
Structural and Systems Biology	Simulations of enzyme catalysis, protein folding, and transport of ions through cell membranes.	**1000**	Ability to discover, design, and test pharmaceuticals for specific targets and to design and produce hydrogen and other energy feedstocks more efficiently.
Catalyst Science/ Nanoscale Science and Technology	Calculations of homogeneous and heterogeneous catalyst models in solution.	**1000**	Substantial reductions in energy costs and emissions associated with chemicals manufacturing and processing. Meeting federally mandated NOx levels in automotive emissions.
Nanoscale Science and Technology	Simulate the operation of nanoscale electronic devices of modest complexity.	**1000**	Takes miniaturization of electronic devices to a qualitatively new level enabling faster computers, drug delivery systems, and consumer and military electronics.
Nanoscale Science and Technology	Simulate and predict mechanical and magnetic properties of simple nanostructured materials.	**1000**	Enables the discovery and design of new advanced materials for a wide variety of applications potentially impacting a wide range of industries, including the high -tech industry that generated more than $900 billion in sales and accounted for 4 million jobs in 1999 and the $34 billion disk drive industry.

Energy and Physics

Biology and Nanoscience

Schedule

February 28 – Memo announcing HECRTF

March 10 – Kick-off meeting

March 28 – First meetings with working groups

April 18 – Call for white papers on HECRTF charge

June 16-18 – CRA workshop with academia, industry, and government

July 4 – First draft for internal review

July 14, 21 – Non-disclosure meetings with industry

August – Plan completed

User and Agency Views on High-End Computing

- HEC solves problems with major impact on society and Government that cannot otherwise be solved

- Current systems
  - Hard to use
  - Enable us to do “old science” well, but not the new science we need

- Mission requirements and scientific leadership require radical improvements in ***time-to-solution***

- Inadequate resources – both capacity and capability

Opportunities

- Move from event-driven investments to one based upon a rational planning process
- Leverage various Agency strengths, capabilities, and resources via improved cooperation
- Rebuild and sustain critical-mass funding levels to attack national challenges
- Rebuild teaming within government, academia, and industry to address pervasive issues

HECRTF Goals

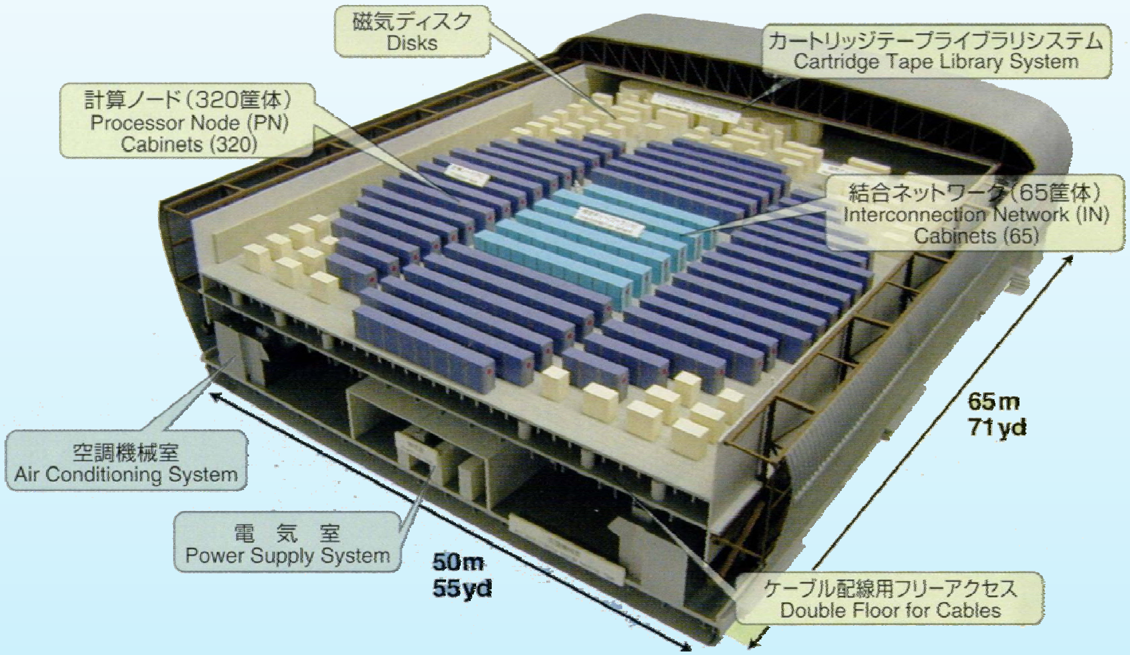
- **Overarching: Revitalize U.S. leadership in high-end computing as a key tool for science and technology.**
  - **Make high-end computing easier and more productive to use.**
  - **Make high-end computing readily available to Federally funded missions that need it.**
  - **Sustain the development of new generations of high-end computing systems.**
  - **Effectively manage and coordinate Federal high-end computing.**

HECRTF Chairs

- **Co-Chairs**
  - **John Grosh (OSD)**
  - **Alan Laub (DOE/SC)**
- **Task Chairs**
  - HEC core technologies R&D
    - **Kamal Abdali (NSF)**
    - **José Muñoz (DOE/NSSA)**
  - Capability, capacity, accessibility
    - **Judy Devaney (NIST)**
    - **Tom Page (NSA)**
  - Procurement
    - **Bill Turnbull (NOAA)**
    - **Phil Webster (NASA)**

The Japanese Earth Simulator

One Scientist's View



- **" … for the first time in my scientific career I find myself having to go outside the U.S. in order to do cutting-edge science."**
  - **Jeroen Tromp, Director & McMillan Prof. of Geophysics, Caltech, May 2003**

The Japanese Earth Simulator

A Center Director's View (Dr. Dan Reed, NCSA)

- **Long term planning matters**
  - Strategic, rather than tactical objectives
  - Multiple generations of implementation
    - Lessons learned influence next generations
- **Goals tied to policy and citizenry needs**
  - Societal benefits and rewards
    - Climate, health, safety/security, jobs, …
- **Resources commensurate with goals**
  - Strategic resources needed for strategic goals

The Japanese Earth Simulator
Task Force View

- Japanese Earth Simulator entered service last March.
  - Took the #1 spot on the Top 500 Supercomputer list.
- What it wasn't:
  - A revelation.
  - A demonstration of US loss of scientific leadership.
- What it was:
  - An attention-getting event that elevated the prominence of what was already considered to be an important issue.
  - A challenge to help provide added incentive for action.
- Federal high-end computing planning was historically not as well coordinated as it should have been.

Computer Research Association HEC RTF Workshop (Chair: Dr. Dan Reed, NCSA)

http://www.cra.org/Activities/workshops/nitrd/

Working Groups, Chairs and Co-Chairs

1. **Enabling technologies**
   - Shiela Vaidya (LLNL) and Stu Feldman (IBM)
2. **HEC architecture – COTS-based**
   - Walt Brooks (NASA Ames) and Steve Reinhart (SGI)
3. **HEC architecture – Custom**
   - Peter Kogge (Notre Dame) and Thomas Sterling (Caltech/JPL)
4. **HEC runtime and operating system**
   - Rick Stevens (ANL) and Ron Brightwell (SNL)
5. **HEC programming environments and tools**
   - Dennis Gannon (Indiana) and Rich Hirsh (NSF)
6. **Performance modeling, metrics and specification**
   - David Bailey (LBL) and Allan Snavely (SDSC)
7. **Application-driven system requirements**
   - Mike Norman (UCSD) and John Van Rosendale (DOE)
8. **Procurement, accessibility and cost of ownership**
   - Frank Thames (NASA) and Jim Kasdorf (PSC)

Major Issues for HECRTF

Technology/Industrial Base

- Research pipeline in HEC almost empty – running out of talent and ideas
- Computer industry focused on building systems targeting business applications. Minimal attention is being paid to the broader requirements of science and engineering applications.
- Industrial base

Suitability and Availability of HEC Systems

- Some Agencies have little or no access to HEC
- Architectures and software poorly support solving large-scale science and engineering problems
  - **Memory wall; Ease of programming; Reliability**
- Growing computational requirements exceed availability, both in size and number of systems

HECRTF Issues

- **Appropriate level and mix of Research, Development, and Prototypes**
- **Balance among hardware, software, and system research**

Final Observations

- HEC RTF is opportunity that may not appear for another 5 to 10 years
- Significant Congressional and Administration interest in HEC
  - Expect HEC community to act like a community … not like Yugoslavia
- HEC competes with other priorities/ideas
  - Information assurance, embedded systems, …
- Huge opportunity to advance computational science and engineering

For Further Information

Please contact us at:

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Or visit us on the Web:

www.itrd.gov